Clean Energy for the Commonwealth
Powered by UMass

Natick Soldier System Center
S&T Board Meeting

Paul T. Kostecki
Vice Chancellor for Research & Engagement
UMass Amherst

April 15, 2009

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Clean Energy Working Group

System-wide collaboration at the University of Massachusetts

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Clean Energy Working Group Progress

2006-07:

- Inventory of clean energy activities system-wide
- Group meetings build inter-campus ties

2008:

- “Clean Energy for the Commonwealth: Powered by UMASS”
- MOU signed between President Wilson and Sec. Bowles

2009

- Collaboration with newly formed MA Clean Energy Center
- Inter-campus research partnerships in clean energy

Matrix of clean energy applications (columns) and selected UMASS research areas (rows).

Solar/Geothermal	Fuel Cells/Batteries	Biofuels	Wind/Ocean	Efficiency/Emmissions
Advanced Polymers and Nanomaterials				
Organic optoelectronics	Nano-imprint lithography	Nanoporous membranes		Nanoparticle-polymer combo. (OLEDs)
Nanofabrication using block copolymer templates		Biohybrid materials	High-strength lightweight materials	
Conductive nanotubes/quantum dots	Nanomagnetics	Zeolite membranes		
Polymer-inorganic nanocomposites	MEMS	Nanostructured catalysts		
Electrical Systems	**Hydrogen Storage**	**Chemical Catalysis**	**Mechanical Eng., Mechatronics & System Design**	**Energy Management**
Quantum electronics	Nano/Micro-electronic sensor design	Fundamental biofuels reactions	Wind resource assessment	Hierarchical power management
Semiconductor thin films	Novel nanostructured materials	- Heterogeneous catalysis	Offshore wind energy	Low-power device networks
Microelectronics	High-surface-area porous materials	- Fast pyrolysis (to bio-oils)	Hybrid systems design	Energy scavenging
		- Microwave control of catalysis	Wind-produced hydrogen	**Enviro. Engineering**
		Catalyst synthesis/characterization	Energy storage	Wastewater energy recovery, re-use
		Bio-oils refining to fuels & chemicals	Prognostics and Health Management (PMH) & control sys.	**Building Design**
		Biomass gasification	Geotechnical evaluation	Heat transfer, Fenestration
Thermodynamics	**Microbial Biotechnology**			Energy efficient and environ-mentally benign materials
Energy analysis	*Geobacter sulferreducens*	*Clostridium phytofermentans*	**Meteorology**	**Carbon Capture**
Theoretical thermodynamics	*In-silico* modeling		Remote sensing	Pollution control technologies
Heat transfer	Directed evolution		Turbulence in stratified flows	CO_2 sequestration (deep ocean/geo)
	Metabolic engineering		Climate modeling	Enhanced oil recovery/extraction
Photocatalysis		**Plant Biotechnology**		
Photocatalytic H_2O purification	Solar-powered H_2 generation	Biochem., Cell wall struct., Agronomy	**Ocean Science**	**Flame Modeling**
Solar-electrolyzer H_2 fuel cell storage		*Crambe abyssinica* – energy crop	Coastal environ. sensing/modeling	Combustion chemistry
Geologic Assessment	**Charge Storage/Conv.**	**Process Engineering**	Quantitative marine carbon cycling	Molecular-beam mass spectrometry
Analytical geology	Electrochemical storage cells	**Biomanufacturing**		
Passive seismic analysis	Nanostructured conducting polymers		**Computational Fluid Dynamics**	
Inventory of New England bedrock geology	Redox charge storage		Dynamics of stably stratified flows	Turbulence modeling
	Supercapacitors	Fuel injection (atomization) modeling		
Environmental, Economic, Industry, Market, and Policy Analyses				

Key Renewable Energy Research Areas

- Wind and Marine Energy - Amherst, Dartmouth, Lowell, Boston
- Advanced Polymers and Nanomaterials for Photovoltaics, Fuel Cells, and Batteries - Amherst, Lowell, Dartmouth
- Cellulosic Biofuels and the Integrated Biorefinery - Amherst, Dartmouth
- Microbial Fuel Cells: Waste to Electricity - Amherst, Dartmouth
- Geothermal Energy: The Untapped Potential of New England Bedrock - Amherst
- Sustainable Design and Green Construction - Amherst
- Business, Competitiveness, and Policy Analysis of Clean Energy and Climate Change - Boston, Amherst

Soldier Systems: Portable Power Research

Applications:

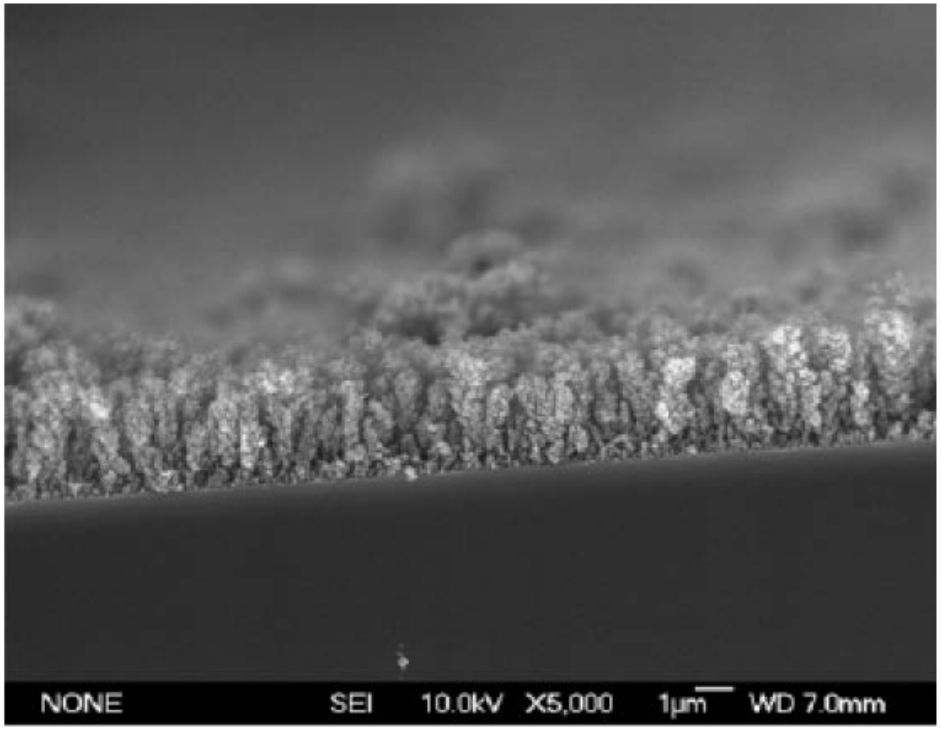
- Thin-film photovoltaics
- Nanostructured light-harvesting materials
- Ultra-capacitors
- Fuel cell membranes & electrodes
- Efficient LED lighting
- Soft electronics
- Hydrogen storage
- Portable microbial fuel cells

Nanostructured Light-Harvesting Materials

Spray on Nanostructured Films

UMass Amherst Center for Hierarchical Manufacturing

- Professor Jim Watkins, Polymer Science and Engineering, Director
- Spray-on technique efficiently creates nanostructured films (titanium dioxide shown).



Panel Spray with Robotic Arm

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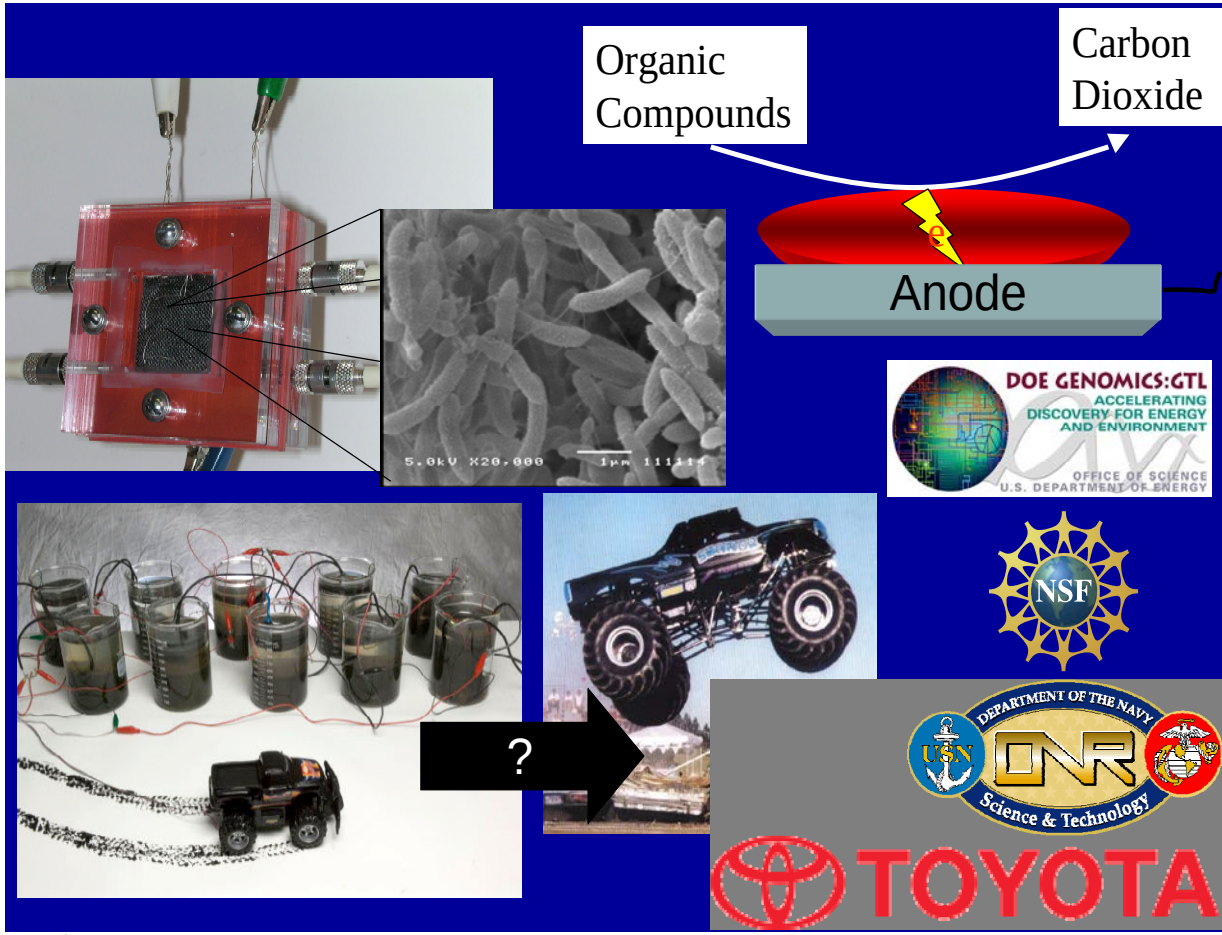
Microbial Fuel Cells: Waste to Electricity

UMass Amherst *Geobacter* Project

- Professor Derek Lovley, Microbiology Department



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Opportunities: Research Centers & Institutes

- MassNanotech Institute / Center for Hierarchical Manufacturing: www.umass.edu/massnanotech
- Fueling the Future Center for Chemical Innovation www.chem.umass.edu/masscrest/fuelingthefuture
- *Geobacter* Project / Environmental Biotechnology Center www.geobacter.org
- Center for High-Rate Nanomanufacturing www.uml.edu/nano

Opportunity: *Carbon Negative* series

- Inaugural seminar: June 11, 4:30 pm
  Foley Hoag Emerging Enterprise Center, Waltham
- Topic: Optimizing fuel cell performance
- Featured Speakers:
  - S. “Thai” Thayumanavan, PhD.
    UMass Amherst Professor of Chemistry and
    Director, Fueling the Future Center for Chemical Innovation
  - Paul Osenar, PhD. Chief Technology Officer,
    Protonex, Inc.

For more information: Portable Power Research

Faculty excerpted from “Clean Energy for the Commonwealth”

Name	Deptartment	Application	Campus
Thayumanavan, S. “Thai”	Chemistry	Fuel cell membranes	Amherst
Therrien, Joel	Electrical and Computer Engineering	Hydrogen storage	Lowell
Qu, Deyang	Chemistry	Hydrogen storage, ultracapacitors	Boston
Lovley, Derek	Microbiology	Microbial fuel cells	Amherst
Watkins, Jim	Polymer Science & Engineering	Nanostructured light-harvesting material	Amherst
Emrick, Todd	Polymer Science & Engineering	Organic LED	Amherst
Russell, Thomas	Polymer Science & Engineering	Organic PV	Amherst
Mead, Joey	Plastics Engineering	Organic PV	Lowell
Ramaswamy, Nagarajan	Plastics Engineering	Organic PV	Lowell
Kumar, Jayant	Physics	Organic PV	Lowell
Calvert, Paul	Materials & Textiles	Soft electronics	Dartmouth
Tuominen, Mark	Physics	Ultracapacitors (nanomagnetics)	Amherst

Additional Resources

- Clean Energy for the Commonwealth
  www.umass.edu/research
- Green Portal
  www.umass.edu/green
- Clean Energy Connections, Nov 10
  www.umass.edu/green